



TagItSmart!

**Smart Tags driven service platform for enabling
ecosystems of connected objects**

Grant agreement 688061



FINAL REPORT

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Final Report

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Approvals

	Name	Organization	Date	Visa
<i>Project Management Team</i>	Leandro Navarro	Pangea	30/12/2018	L.N.

Document history

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v2.3	29/12/2018	Consistency check and final reading	Xavier, David, Leandro
v2.4	30/12/2018	The revised version of the deliverable	Leandro



Part A. Summary of the work performed so far

The summary of the work performed during the project has been around the use case of a “Circular Economy” of “slow moving” circular goods (SMCG): **1) Designed, printed and tested the smart tags we need for our use case.** Our tag has been defined with Dondelotiro, Durst, Evrythng, Thinfilm and VTT. We have tested its resistance (environmental factors, friction) and performed data reading tests with our own smartphone app. **2) Developed and tested the software modules for compatibility and integration with the TIS modules.** We have developed a new eReuse.org module named Tag, a server that connects and manages smart tags with the rest of the modules and platforms. We have reimplemented our main module Devicehub and developed a new micro-framework to allow the compatibility with Evrythng TIS module. We have extended our Smartphone app to be compatible with NFC chips. We have tested and integrated modules of the TIS platform with eReuse, resulting in the eReuse/TIS platform. **3) Developed and tested the eReuse.org software modules to implement the SMCG use case.** We have generated the user stories to meet the new requirements and we have added new features to eReuse modules. **4) Pilot implementation.** We have three pilots: 1) Preliminary pilot and integration, 2) Pilot experiment with our primary customer segments: retailers, refurbishers, ITAD, recyclers, digital divide initiatives and end-users, and 3) Pilot experiment with our secondary customer segments (buyback service, exporters) and validation of implementation for the complete revised system. **5) Marketing and dissemination.** We have identified and worked with key dissemination partners such as Zero Waste Europe and the Association for Progressive Communications, in addition to TIS partners. We will continue to focus on the creation of local reuse circuits in European municipalities and support the eReuse community to upgrade to the new version of the tools developed in this project.

All the objectives set by the project have been achieved, although we had to request the extension of the project by one more month to complete all the objectives. The reason for the delay was our smart tag design and printing. Our tag design proposal was finalised in mid-May (M5). However, we have made three minor prototypes to test the material, the adhesives, the reaction time of the inks, and the technology necessary for their reading. This added 1 month delay, and due to a printing error of our partner we had another month of delay. In the end, we received the final tags by mid-August (M7), a delay of 2 months to start the pilot. Some tasks were anticipated but the delay could not be fully recovered, finishing the deliverables at the end of M11, not by M9 as proposed.

Finally 14 project deliverables were delivered, plus 2 requested by TIS, in total 16.



Part B. Detailed description

This is the complete list of eReuse project deliverables:

Deliv #	Deliverable name	WP number	Type	Dissem level	Deliv. date
D1.1	Midterm report (draft)	1	Report	Public	M3
D1.2	Final management report	1	Report	Public	M9
D2.1	System architecture and design	2	Report	Public	M2 / M9
D2.2	System prototype	2	Software	Public	M3
D2.3	Process design (draft)	2	Report	Public	M3
D2.4	System (final)	2	Software	Public	M8
D2.5	Process design (final)	2	Report	Public	M9
D3.1	Use case & pilot design	3	Report	Public	M2
D3.2	Use case pilot (interim)	3	Report	Public	M6
D3.3	Use case pilot (final)	3	Report	Public	M9
D4.1	Dissemination plan	4	Report	Public	M2
D4.2	Marketing and exploitation strategy design	4	Report	Private	M3
D4.3	Marketing and exploitation strategy strategy final	4	Report	Private	M9
D4.4	Dissemination results	4	Report	Public	M9

B.1 Concept, Objectives, Set-up and Background

B.1.1. Concept: A service platform for enabling circular economy for electronic reuse.

A circular economy is about capturing value lost in traditional linear systems. This implies transforming the linear supply chain into loops that retain more value. It goes beyond recycling, involving repair, refurbishment and reuse of products where more of the original value is captured with reduced environmental impact. The Electronic Reuse community (eReuse.org) has proposed to develop the use case of a “Circular Economy” of “slow moving” circular goods (SMCG). Specifically, we work with a key subset of SMCG: digital devices (laptops, desktops, monitors) to extend the lifetime of digital devices as long as possible by repairing, updating, and reusing them.

In our use case, used SMCG came from the city council of Barcelona. These devices were inspected internally by refurbishers through analysis software tools (ereuse/TIS workbench), creating for each device a diagnostic report stored in the ereuse/TIS platform. Sellers of second-hand devices create a diagnostic report link to the product and this create trust on consumers buying through e-commerce online as well as physical shops.



In addition, the reliability in locating the devices and its path along the reverse supply chain generates trust among the stakeholders and customers. With the eReuse/TIS platform the chain of custody of the devices can be traced so the City Council of Barcelona, today knows which agents and users have refurbished, retailed, reused, and finally recycled its devices, thereby creating concrete local jobs, improving efficiency and enlarging trade volumes in the second hand computers market. This results in benefits from positive externalities of job creation, enhanced economic activity on the refurbishment, support and recycling sectors.

DeviceTag.io is a project under the Pangea non-profit SME focused on the generation of social and environmental value resulting from the use (and reuse) of digital devices. DeviceTag.io offers eReuse/TIS. As a result of the integration between eReuse and TIS we have an eReuse/TIS platform, a set of integrated web tools with the main objective to create and exchange digital device life-cycle data during the full life span. This is offered as a SaaS to sellers and electronic reuse platforms.

B.1.2. Objectives: TIS integration, pilot and dissemination.

KPI	Measure of the indicator	Measurmt period	Target Value	Measured Value
KPI 1 - TIS	KPI1.1 # of key eReuse.org software modules integrated to TIS and TIS modules used	9M	1,2,4	9: WorkBench Computer, Workbench Server, Android App, DeviceHub, Tag, smart tag NFC, smart tag photocromic, EVRYTHNG Virtual entity/Data Repository
KPI 1 - TIS	KPI1.2 TIS use case business needs deployed (e.g: buyback, retailer, refurbisher,...)	9M	1,4,8	8
KPI 1 - TIS	KPI1.3 Define partnerships with TIS partners (data agreements, confidentiality restrictions and IPR)	9M	1,2,3	4: ThinFilm, Dondelotiro, Durst, Evrythng
KPI 2 - Pilot	KPI2.1 Pilot: # of devices managed & tracked w/TIS integration	9M	250, 400, 600	96: devices with new tag 744: devices interacting partially with TIS integration.
KPI 2 - Pilot	KPI2.2 Market: eReuse.org customers testing TIS	9M	2, 4, 8	7: (note: exporters have not interacted with the tag, only with the system)
KPI 2 - Pilot	KPI2.3 Increased platform usage due to TIS integration	0M, 3M, 9M	5%, 15%,	500% increase in # of devices, 100% increase in # of customers.
KPI 2 - Pilot	KPI2.4 Customer satisfaction increased due to TIS integration	0M, 3M, 9M	5%, 15%	20% of customers confirm new features were a must to go ahead on using our service
KPI 3 - CE	KPI3.1 Dissemination: Spreading TIS Ecosystem	3M, 9M	4 (events or pubs)	24 actions in total: 18: events, 1: paper, 1: case study, 4: media
KPI 3 - CE	KPI3.2 Marketing: Price of assets managed in TIS (~100€ /	3M	15,000€	74,000 € from 744 devices interacting partially in the platform



	item)			
KPI 3 - CE	KPI3.3 Relationships with other key interested shareholders willing to know about TIS	3M	10	11 + 30: ZWE, Catalan Waste Agency, JRC, APC.org, EEB, RREUSE, TheRestartProject, Repairably, ElectronicsWatch, OPenRepair.org, Rezero, Consortia OBADA (30 entities)

B.1.2.1. eReuse development and TIS Integration (KPI 1)

This objective consisted in development of the eReuse.org software modules for compatibility and integration with the TIS modules.

Deliverable **2.1 System architecture and design** describes the proposed architecture and integrations done (updated at M10), which has derived to the one presented in section B.2 Technical Results.

Below we offer a brief description of the KPIs achieved:

- KPI1.1 # of key eReuse.org software modules integrated to TIS and TIS modules used. In total, between ereuse modules integrated in TIS and used TIS modules, we have a total of **9 modules (KPI 1.1)**.
- KPI1.2 TIS use case business needs deployed (e.g: buyback, retailer, refurbisher). Deliverable **2.5 Process design (final)** describes in detail the processes in which these modules are used for the eight customer segments (**KPI 1.2**).
- KPI1.3 Define partnerships with TIS partners (data agreements, confidentiality restrictions and IPR). The use of these modules has led to 4 collaboration agreements (**KPI 1.3**) between the entities ThinFilm, Dondelotiro, Durst, Evrythng.

The following is a brief description of the modules developed and used (KPI 1.1). The source code for the eReuse.org modules is in Deliverable **2.4 System final**.

1. Workbench Computer: A software that executes on a computer and, without human interaction, automatically executes several tools (hardware discovery, eraser, benchmarks, tester, GNU/Linux OS installer).
2. Workbench Server: A software that manages the execution of the Workbench tool on multiple devices (up to hundreds) through a local network.
3. Android App: A smartphone and tablet Android app that has two functionalities: 1) Obtain metadata from devices that are not computers, like peripherals or electrical appliances, by scanning their barcodes and taking pictures of them, and link devices to QR/NFC smart tags. We have extended our Smartphone app so it is now compatible with NFC chips.
4. DeviceHub: a distributed Device Management System on the cloud that several actors use to manage the devices, tag them with TIS tags, and record the exchange of them. The DeviceHub module (Python-Eve, Flask, MongoDB) was outdated and did not allow us to integrate with TIS platform. We needed an extra effort to replace



the technology to a RESTful Python 3 web application built on an open-source micro-framework ([Teal](#)) we have developed as part of DeviceHub. Teal is built on Flask and uses a PostgreSQL database.

5. Tag: is a software that manages the TIS smart tags. It generates the information the TIS NFC/QR tag manufacturer requires (Tag ID and QR value) in order to create the tags and then it links it back with the NFC information the tag manufacturer sends with the new tags. Moreover, it allows to send this information to instances of the Devicehub service so users can work with them.

Our tags have been defined with Dondelotiro, Durst, Evrythng, Thinfilm and VTT. We have 2+ tags:

6. Smart tag NFC: A NFC chip and a QR code printed on the chip to uniquely identify the devices and ensure that tag duplication is prevented,
7. Smart tag Photocromic: A photochromic reversible tag to help the end-user to identify a legitimate device that has been correctly refurbished by an eReuse.org authorized refurbisher without the need to read the NFC chip.
8. EVERYTHING Virtual entity: The Devicehub creates or updates a virtual entity in Evrythng containing the device and the tag identifiers. If Devicehub or Everything detect that the tag was already linked they won't allow this operation. Devicehub can only detect if the app is linked by looking at its internal database. Evrythng, as it contains all device and tag information, can validate that the tag is not linked elsewhere.
9. EVERYTHING Data Repository: The Evrythng platform stores a copy of device, tag, and action information, that is submitted by Devicehub after the user performs these. For example, after the user records a sale, the sale information is uploaded to Evrythng.

B.1.2.2. Pilot

We have designed and developed our SMCG use case with the eReuse community, generating their corresponding user stories to meet the new requirements, mapping business needs by customer segments, and the pilot design and implementation.

Below we offer a brief description of the KPIs achieved, described in more detail in deliverables **3.3 Use case pilot (final)** and **4.3 Marketing and exploitation strategy final**.

- KPI2.1 Pilot: # of devices managed & tracked w/TIS integration. A total of 96 devices have the TIS smart tag. With these devices all possible interactions have been performed, from the collection from the first owner to the delivery to a customer. Anyway, the ereuse/TIS system has 744 devices (end December 2018) with 200 newly added monthly.
- KPI2.2 Market: eReuse.org customers testing TIS. With the exception of exporters, all customer segments have interacted with smart tags. The exporters have interacted with the ereuse/TIS platform when generating the export reports including the serial numbers required in customs control.
- KPI2.3 Increased platform usage due to TIS integration. We have had a growth of more than 500%, starting from October 2017 with a 3-month average of 40 new



devices per month, until October 2018 with an average of 210 new devices per month. We have doubled in 2018 the number of active users of the system, from 9 to 18. For next quarter we expect addition of 12 new users who have already expressed their intention, resulting on a total of 30 users by the end of next quarter, 21 of them from TIS related activities.

- KPI2.4 Customer satisfaction increased due to TIS integration. 20% of customers confirm new features such as non duplicable tag and URL pointing to device information were a must to decide on using our service.

B.1.2.3. Dissemination, exploitation and marketing

The third objective is dissemination, marketing and exploitation of the project results and interaction with related initiatives. The work of WP4 has produced two deliverables D4.1: Dissemination plan (M2) and D4.2: Marketing and exploitation strategy design (M3). The funding of H2020 – TagItSmart has been acknowledged in these events and documents.

- KPI3.1 Dissemination: Spreading TIS Ecosystem. In deliverable 4.4 Dissemination results we describe in detail the different dissemination actions, with a total of 24 actions carried out in 18 events, 1: paper, 1: case study, 4: media content. The last action has been the development of a case study [1] and the scheduling of a monthly webinar with European municipalities starting from February.
 - KPI3.2 Marketing: Price of assets managed in TIS (~100€ /item). From February to November, a total of 744 devices have entered the platform, interacting with the different modules of the reuse/TIS platform. Of these, 96 have used smart tags.
 - KPI3.3 Relationships with other key interested shareholders willing to know about TIS. We have established relationships with the following 11 stakeholders: Zero-Waste Europe (ZWE), Catalan Waste Agency, JRC, APC.org, EEB, RREUSE, TheRestartProject, Repairably, ElectronicsWatch, OpenRepair.org and Rezero. Since September, we have participated in the OBADA consortium - The Open Blockchain for asset disposition alliance where more than 30 entities participate, for the definition of a standard and protocol for the traceability of electronic devices in a blockchain.
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B.2 Technical Results

In the following system architecture we present the main interactions between the devices used in the pilot, our customer segments and the TIS platform.

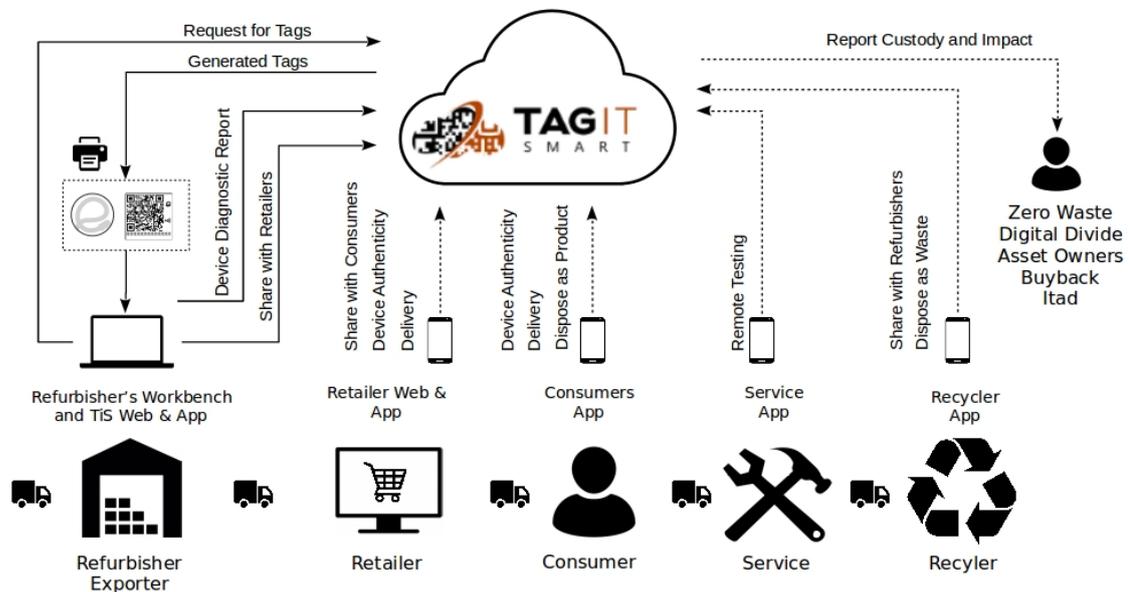


Figure 1: Use case participants and system architecture

As a result of the integration between eReuse and TIS, the eReuse/TIS platform consists on a set of web tools with the main objective to create and exchange digital device life-cycle data during the full life span with the following characteristics:

1. Devices have a non copyable tag pointing to its life cycle data.
2. The characteristics and use-value of a device is estimated based on automated diagnostics.
3. Each device leaves an immutable trace of its history, the reverse supply chain.
4. Devices are traced according to related standards.

In practice, an eReuse/TIS platform provides device suppliers with a guarantee that their devices are used/reused and finally recycled, avoiding illegal trade and reducing environmental impact, and provides to sellers with a service to create diagnostic reports to know condition of devices and share it with consumers.

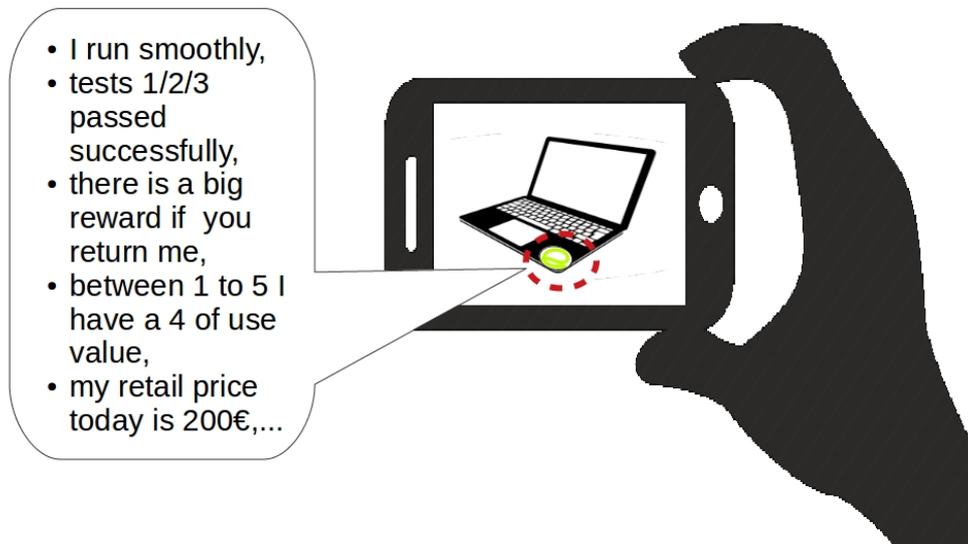


Figure 2: Check device authenticity and show key information at the instant of purchase

Customers can use a smartphone app to check the tests, characteristics and authenticity of a device and show other key information at the instant of a purchase decision (see above figure).

Deliverable 3.3 details the implementation of the pilot, the participating actors, and screenshots of the eReuse/TIS platform. Deliverable 2.5 provides the technical aspects.

B.2.1. Put second-hand first with trust between sellers and buyers

With rising prices and durability of devices it makes more sense to apply the recipes of the automotive industry: why not a carfax.com of digital devices? In the second-hand world the consumer wants to know he is buying devices with good quality components. With the TIS platform today we can offer a service to sellers, marketplaces or individual users who want to sell second-hand devices. This service generates a certification document (and URL) with the characteristics and operating status of each specific device.

B.2.2. Increase second-hand purchase with the device use-value characteristic

Related to the previous point, nowadays users buying second-hand devices have a new indicator called "device use value". A value ranging from 0 to 5 that estimates the state of functioning and the features provided by a device. The input data for the algorithm has been retrieved automatically using the eReuse tools. This use value estimation is itself a benchmark that remove techie terms from the product description such as speed, number of cores, etc. A value within [0, 2) is considered unusable; this device either does not have all the necessary components or has insufficient performance to run a modern operating system and the most common applications. A device within [2, 3) is considered low range, which is sufficient to be used, but with limitations. A device within [3, 4) is considered a mid-range device that can be used for most applications, and a device within [4, 5] is a high-range device.



B.2.3. Ensure condition and compliance in the chain of custody

Today with TIS we can find out about the condition and history of digital devices throughout their life-cycle until their final recycling. Second-hand sellers can use a non-copyable smart tag that link devices to unique URLs for keeping track of their way through other organizations, locations, and changes in quality and condition of their components. An smartphone APP track transfers and processes (Transfer, Collect, Refurbish, Recycle, ...), storing this data in a Distributed Ledger (ereuse DeviceHub) recently integrated to the TIS platform and in compliance with the GS1 standard that enables trading partners to share information about the physical movement and status of products.

B.2.4. Increase platform collaboration with transparency in the reverse supply chain

The certainty that device scores cannot be manually altered is creating new forms of collaboration. Large donations presented problems for storage, processing effort and finding a market. Today may be easier by combining reuse business activities, specialized resources to support different tasks in the reuse chain, allows reuse centres and retailers to scale-up their operations and collaborate to process more devices per month without discarding any donation. To give an example, the Digital divide NGOs ongdreamit.org acquire devices from suppliers (e.g IBM) and offer part of them to refurbishers (e.g lakalle.org) in exchange for refurbishment services.

B.2.5. Avoid premature recycling with immutability of the reverse supply chain

Although public authorities and some private organisations are willing to promote reuse and being a supplier/donor providing its digital devices to electronic reuse platforms, they face a key obstacle in that the devices lack proper traceability. This creates a situation where used electronic devices can be illegally exported and pollute the environment without any trace. This use case, developed with the Barcelona City Council, aims to provide the transparency and incentives necessary to guaranteed reuse and ensure safe recycling. With TIS platform, both the City Council of Barcelona, the reuse provider and the manager of the reuse center can check the location of any device at any time, as well as monitor the place at which it is recycled. Nowadays, the knowledge about which agents and users have refurbished, retailed, reused, and finally recycled its devices, is recorded. Therefore stakeholders can rely on this data and remove the fear of duplication of tags and malicious alteration, thanks to the use of non-duplicable TIS smart tags and because transactions are recorded by ereuse/TIS DeviceHubs and cannot be retroactively altered protected from changes by all subsequent blocks. The next features, already tested, is to record price transactions in a public ledger such as blockchain offering this feature by blockchain EVERYTHING modules.

B.2.6. Maximum selling price for digitally excluded people

One of the main restrictions of the donors of used devices, especially from public administration, is that the price of devices for digitally excluded people must be cost-oriented, not profit-oriented. That applies for example to costs of reuse services such as management, transport, storage, refurbishment, retail and traceability. To ensure that we make this information publicly accessible through reading the smart tag or accessing to the device URL from any e-commerce site offering them. Changes in the sale price of the devices are recorded on the website of a device so that a consumer in that capacity of beneficiary can



always retrieve with the invoice link. The next step is to record price transactions in a public ledger such as blockchain offering this feature by blockchain EVERYTHING modules.

B.2.7. A system reliable by design and robust to attacks

The integration of ereuse.org software modules and TIS, has resulted on a full life-cycle asset management system reliable by design. Three key features make the system reliable:

1. The device information cannot be altered manually because it comes directly from the eReuse Workbench output and a smartphone app that record the life cycle of SMCG products,
2. The platform does not allow the same device to have more than one virtual representations (URL) because the system creates a device ID and URL composed by serial numbers of internal components,
3. Each device has a non copyable smart tag using NFC from TIS partners.

If a malicious actor wants to duplicate tags from a single high-performance device it can be detected because smart tags cannot be duplicated (the tag is unique) and URLs cannot be duplicated (these are built from the internal component IDs that are part of a device, which are unique).

B.2.8. Easy and secure bulk identification and refurbishment of devices

We have improved the performance of this process, that brings automation, cost reduction, traceability, and auditability to all the process performed to refurbish and repair a device. The result is 3 min dedicated to the following tasks: operator/device parallelization, certification process, customization, integration, secure data wiping, functional tests, hardware discovery, benchmarks, rating systems to assess the potential for reuse, integration with device inventories. The ereuse.org quality and traceability process is at Technology Readiness Level 7, fully integrated in the TIS platform with many other software modules.

B.2.9. Easy classification as ewaste or product

We have extended ereuse Workbench with new tests. For example, we now perform CPU benchmarks among other tests. As a result, those responsible for monitoring the export of waste can automatically know whether or not a device works without having to power it and boot it up just for its classification either as ewaste or usable.

B.2.10. Evrythng integration

Regarding the EVERYTHING environment, we see great potential for integration that we describe below:

- Methods and software tools to extract data from computer-based electronic devices (computers such as desktops and laptops, bootable with our Linux-based tools) that can extract detailed component data (characteristics, serial numbers) and perform related actions (erasure, health or stress checks) [ereuse Workbench]



- Methods, software tools and services to link/map extracted data about devices to unique identifiers (for product items: *products* and *things* in Evrythng terminology) that can be represented as RFID tags, eTags, or QR codes. [ereuse DeviceHub]
- Methods, software tools and services to keep track of a distributed inventory of devices, and related events [DeviceHub] implemented as a repository (here is where the Evrythng API and service can be used as a centralized store for this information).

EVRTNNG is going to be used as a Global Record of Devices (GRD) (see deliverable 2.1 System Architecture and design). The GRD is an auditable (and replicable) online log that maintains a global list of traceability information about devices, so it can assist in case of a leakage event or similar problems. The GRD stores and offers open-data and is designed to be used by external users who want to report or check traceability information. At the same time, the GRD aggregates traceability data with the objective of using this data as inputs for indicators measuring circularity.

For the GRD, today EVRTNNG provides a REST API that allows ereuse DeviceHub, to report about the life cycle of devices, environmental responsibility for organizations, etc. It collects from each device, at least, the geographical paths it has followed (not in detail to preserve privacy), the DeviceHub where it has been stored, the collection points where it was located before its final recycling and, in the case of computers, the list of records about their components.

The information from ereuse Devicehub is given to EVRYTNHG, for example, for compliance with international trade processes using the EPCIS, a GS1 standard that enables trading partners to share information about the physical movement and status of products as they travel throughout the supply chain – from business to business and ultimately to consumers. In fact GS1 covers aspects to achieve interoperability, visibility and automation, through standards about identification (codes: global trade item number, container GTIN, locations: GLN), capture and sharing (keys, GDSN, eCom, EPCIS).

Places and locations are relevant to our customer segments, as events may have a context related to places (a real-world location where a product or thing may be interacted with) and locations (the point where an item is or an action happened). Evrythng uses the GeoJSON Point specification (RFC 7946) and the address data type. For example, a polygon represents for us a valid area of the perimeter of a recycling center.

Furthermore, the Evrythng API and service supports additional features like actions, interaction with web applications (such as external mobile or web apps that interact with the API/service), auth (OAuth, etc).



B.3 Lessons learned

Through implementing and validating new eReuse modules and processes for the TIS integration during the use case pilots, we gained the following insights:

B.3.1. Tag design decisions

- Through NFC, devices are scanned faster and more reliably, especially in low-light conditions providing easier and more comfortable identification of devices and more secure.
- We have implemented a secure and an insecure option:
 - The insecure option does not use the NFC tag, it uses the URL extracted from the QR, but to improve the security of this option (for users who do not have an NFC reader on their mobile) a photochromic tag has been added to let the user validate the authenticity of the tag by inspecting how the tag changes color when exposed to the torch light of his mobile.
 - The secure option uses a smartphone app that reads the URL inside the NFC chip. We've tested resistance (to environmental factors such as traction, friction) and data reading tests with a smartphone app.
- Maintaining QR codes in addition serves as backup for user devices not capable of reading NFC and may be easier in some use cases, e.g. end-users more familiar with QR codes.
- TIS smart tags are globally unique and thus prevent registration of two devices with same identifier, further preventing errors in device traceability.
- TIS smart tags can not be copied or tampered with, increasing security and trust in the system.
- NFC tags dramatically increase the speed and comfort of bulk processing of devices in comparison to bulk processing with QR tags. As NFC tags do not require using the mobile phone's camera, bulk scanning of NFC tags can be done only by tapping the phone's NFC reader on devices sequentially, without having to interact with the mobile phone's screen.
- The photochromic tag provides a quick way for the end-user to validate the veracity of the tag by just illuminating it with the torch light of his mobile.

B.3.2. Centralized distribution of smart tags supplied by verified manufacturer

Customers registering devices with new smart tags such as refurbishers and ITAD/ITAM, need to obtain the tags from a supplier instead of printing them locally as they did with QR tags used in the existing eReuse system. We found that this is best done through a local single entity, which will keep track of smart tags inventory and deliver them to other organizations directly. The entity most suited for this task is the organization that also manages acquisitions with ITAD/ITAMs and refurbishers as they carry the main responsibility



for device custody and therefore are also responsible for distributing smart tags to refurbishers so that they can attach them to newly registered devices.

B.3.3. Explore TIS blockchain modules to use it as proof of record

We found the need to further decentralize information to increase security and trust in the system. As a result, we investigated and prototyped using a permissioned blockchain to store events used for device tracing. EVRTHNG offers a blockchain connection module that can be used for this purpose.

B.3.4. New business case: robbery of original components (Walmart and Dell)

During the project we have detected new cases of use, the most relevant is the problem between Dell and Walmart. There are several cases of people buying Dell computers in Walmart that later return them with changed low quality components. Walmart doesn't know about it and it generates a lot of losses. The solution would involve using the TIS platform to record a snapshot of the device before selling and after its return to verify for any tampering replacing components.

B.3.5. Usability improvements on web platform and Android app

The web platform can be more easy to use and facilitate maintenance of the chain of custody of products, i.e. the appropriate registration of device events. The Android App requires better support for ongoing inventory stock management, e.g. through scanning devices and updating their status. NFC-enabled smart tags have improved this process significantly.

B.3.6. A global record of devices and GS1 standard

We are going to use EVRTHNG as a Global Record of Devices (GRD) (see deliverable 2.1 System Architecture and design). EVRTHNG provides a REST API to allow reuse DeviceHub, to report about the life cycle of devices, related to environmental responsibility for example, for compliance in international trade using a GS1 standard that enables trading partners to share information about the physical movement and status of products as they travel throughout the supply chain. In fact GS1 covers aspects to achieve interoperability, visibility and automation, through standards about identification (codes: global trade item number, container GTIN, locations: GLN), capture and sharing (keys, GDSN, eCom, EPCIS).

B.4 Impact

B.4.1. Impact that would enhance innovation capacity

The main impact comes from the definition of a key use case for circular economy of SMCG, the extension of the TIS platform to cover this use case, and the development and piloting of business models and solutions for this sector with large and growing business needs, and public interest.

B.4.2. Create new market opportunities

In wholesale (B2B) and retail market places (B2C) of second-hand devices, for example mobile phones or laptops, sellers do not offer certified information about the characteristics,



quality, and operating status of the devices they want to sell. To reduce the risk they could obtain certified information on the condition of the devices that are published for sale. We can offer a service that generates a document (and an URL) with this information, allowing the seller to add or link it to the product description. This service could be addressed to sellers, marketplaces or individual users who want to sell second-hand devices. Currently, wholesale and retail market places assume the risk and losses (warranty, return).

B.4.3. Strengthen competitiveness and growth of companies

The results from the TIS project provide the technological capacity and differential value to scale the solution, already running in Spain with 15+ organizations involved, at European level. The previous eReuse solution did not use smart tags and this was a barrier. Smart tags and their capabilities to prevent tag duplications provide means to ensure product quality in refurbishment, protecting brand image, consumers, governments willing to prevent [illegal trade](#) of ewaste (EC COM(2017) 33) to retain as much as possible raw materials in Europe. The selling price and receiver demand values are returned by an app in a way that contributes to reduce uncontrolled dumping with donated devices or ensure they are sold at affordable prices to target audiences. The value of the resource (current and if repaired) is returned by an app, enabling a data-driven decision-making to going forward in the implementation of the circular economy, so we only recycle when the product's use value is lower than extracting its raw materials (European Environmental Bureau, Circular Economy Package 2.0).

The resulting TIS platform has enabled to create B2B marketplace between retailers, refurbishers and repair business. This improvement in technology makes possible to improve the supply of products destined for internal demand in Europe, in order to progressively reduce the number of products exported outside Europe for their refurbishment (today 68%, CWIT 2015). TIS partners can offer a solution to cover and adapt this growing market. The TIS solution now includes traceability at component level to ensure recycling of the reused material. A research about illegal trade of Waste Electric and Electronic Equipment (WEEE) found that from 9 Mt of WEEE in Europe, only 35% ended up in the officially reported collection and recycling systems, and the remaining 65% were: 24.39% exports (of which 86% illegal exports), 51.22% recycled under non-compliant conditions in Europe, 12.2% scavenged from valuable parts, and 12.2% thrown in waste bins. With TIS and traceability we can ensure more devices are recycled, getting near 100% of internal components. We estimate the economic value of the devices reaching the recycler is around 200€ C/tonne when incomplete, and around 800€ C/tonne when complete.

B.4.4. Bring other important benefits for society

Finally, we should not forget the impact of reuse on reducing the digital divide. Traceability of used products can be made visible showing the full cycles of reuse with the chain of business and users all through until recycling. This ensures that donated computers from public sector are sold with a limited profit margin and the final recipient pays an inclusive price. That impacts on cost savings on subsidies of governments related to resource pooling, create social and local economy, digital inclusion and prevent electronic waste by extending the lifespan of electronic devices. In the ereuse.org platform, desktop computers are valued around 80€ to 110€ for laptops, and currently within public institutions more than 80% of digital devices to be recycled are still operational (without need for repair).



B.4.5. Potential for technical and commercial application

For whom is DeviceTag.io creating value? Who are their most important customers?

In practice, an eReuse/TIS platform provides to his customer segments the following properties over devices they own:

- To second-hand device sellers it offer secure diagnostic and benchmark system to store quality reports and erasure certificates with proof of record. This is done in a one-step automatic process. For example, a seller publishes on an marketplace or shares the device they want to sell and the buyer can view the tests performed.
- To resellers and service providers we offer a service to track their service history, receive automatic service alerts and get critical information about open safety recalls reported for their device, set take-back and buyback procedures and create a product passport to not loose traceability until recycling.
- EARLY ADOPTER: Second-hand device suppliers can view the chain of custody of devices. This is useful for public administrations, zero waste platforms and circular economy investors to verify where second-hand devices are reused / recycled.
- FUTURE: Service Providers, ITADS, resellers, retailers, governments and other actors can create smart contracts that automatically compensate supply chain actors to solve the problem of programmed obsolescence and make a better waste management for increase circular economy.

We currently see two key services to offer. The first one is oriented to second-hand technology sellers, and the second one to suppliers or reuse platforms. In the future we see a potential in smart contracts service, although this is still premature to address a market and cost study. They are described below:

- Device Erasure, Diagnostics and Benchmarks: Mass identification of devices with verified pre & post repair hardware diagnostics, and benchmarkings. The hardware identification accuracy is now around 98%. Auditability to the processes involved in refurbish and repair of devices, including data wiping, diagnostics, and benchmarking. The resulting reports and certificates (which are in a standardized format) are stored in a cloud, with proof of record. Related to that, there are a set of tools for device rating, pricing and sharing devices based on open standards to assess the value of use and features of devices, hardware discovery, algorithms (scoring, visual grading), signed process, and remote assessment (Desktop APP).
- Device Traceability: The software links each device with a standardized digital passport, consisting of an URL with device characteristics (like serial numbers), certificates, diagnostics, chain of custody, and proof of record. Specially durable and uncopyable Smart tags (QR / NFC / Photochromic TagItSmart tags) that certify device veracity. Device custody and license compliance is based on a distributed system using open traceability standards. The document pointed by the device URL describes the take-back mechanisms to collect and assess devices from consumers (recycling or new reuse cycle).
- FUTURE: Device SmartContracts: a Blockchain as a trusted proof of record of the device metadata, traceability events, reports, certificates; avoiding modification and adding trust between actors. A secondary system stores the private information and



references a blockchain transaction. Contracts can coordinate the economic compensation of supply chain and reverse logistics actors, keep an intricate accounting for compensating reuse supply chain actors after selling devices or when distributing governmental recycle tax. Government and other actors can create smart contracts that automatically compensate supply chain actors on certain events.

More details are provided by deliverable 4.3 Marketing and exploitation strategy.

B.4.6. Describe how the proposed extension has sufficient sustainable benefits for the TagtSmart project

The eReuse extension expands the scope of the TIS project to the section of the circular economy with its main feature of traceability of items with a large usable life, large environmental impact in the manufacturing and destruction of these, and ability to be reused and repaired. eReuse explores and develops the specific case for computers and the use of smart tags in that context, but the lessons learned, the experience, the validation and integration with TIS tools and services apply to the general circular economy, an important sector that will only grow very quickly as our society has reached already environmental limits and has started to suffer the drawbacks and catastrophic effects of climate change.

Part C. Resources

C.1 Resources Deployed

The table reflects the Resource Expenditure sheet by the end of June. All funding resources have been spent at the end of the term as planned (December 2018) to at least 100% (final details will be available soon).

Cost category	Budged according to the TagtSmart Standard Expansion Contract	Costs incurred within the extension duration	Remaining %
1. Personnel	€ 99.225	€ 43.561,62	44%
2. Travel	€ 12.000	€ 9.775,69	81%
3. Other	€ 8.000	€ 7.382,76	92%
4. indirect	€ 29.806,25	€ 15.180,02	51%
TOTAL	€ 149.031,25	€ 75.900,09	

C.2 Further development and exploitation

The TIS integration has improved the main processes of eReuse and subsequently enabled relevant user stories of diverse customer segments of our use case, the “Circular Economy” of “slow moving” circular goods (SMCG). The use of NFC-enabled tags, smart tags (NFC) that can not be copied or tampered with has increased the security and trust in the system. eReuse/TIS will allow customers to report the life cycle of devices, comply with environmental responsibilities for example, compliance with international trade using GS1 standards that enables trading partners to share information about the physical movement and status of products as they travel throughout the supply chain.



Throughout the document we have identified potential improvements, which we now summarize:

- Digitally sign the test (inventory) output, to detect and prevent from data changes and data loss.
- Automatically store the test result not only in the local devicehub but also in another system (Evrythng TIS module) that prevents the devicehub administrator to modify the test result directly in the database. At this point we consider the usage of blockchain as an alternative.
- Distributed device inventories reporting to others to simulate something equivalent to a permissioned blockchain and reporting to Evrythng as a data record that stores decentralized information.
- Explore existing modules for e-commerce, especially in the field of logistics.
- Explore the use of analytical modules that allow us to identify and represent the life cycle of devices that go through various devicehubs, perform analysis on device durability, and in general all those functions that TIS offers us to be able to concentrate our efforts on our main contribution and added value.



Part D. References

[1] Zero Waste Case study of eReuse/TIS. <https://zerowasteurope.eu/2018/12/press-release-case-study-ereuse/>